Volumetric MRSI as a tool to guide and monitor radiotherapy treatment in patients with glioma

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Target audience: Research scientists, medical physicists, radiation oncologists, neuroradiologists who are interested in brain tumor mapping.

Purpose: Proton MR spectroscopy imaging (MRSI) can be used to distinguish cancerous tissue from normal tissue, since brain cancer cells generally have a different metabolic profile. Increased choline has been particularly associated with brain tumors [1]. Therefore, MRSI may help guide radiotherapy treatment target volume optimization as well as monitor treatment response [2]. Volumetric echo-planar spectroscopic imaging (EPSI) was used to determine choline (Cho) levels throughout the brain in patients with glioma before starting radiation treatment. A second EPSI was acquired during the last week of treatment to determine whether changes in the choline signal have occurred.

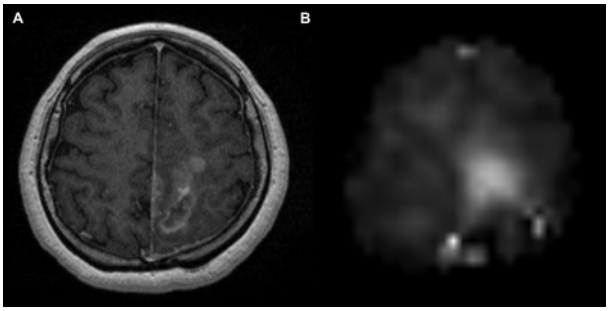

Fig.1: Post-surgical pre-radiation A) contrast enhanced T_1-weighted image and B) corresponding choline image.

Methods: 31 patients with high grade glioma were recruited of who 25 (M/F=13/12, age 26-76, 53±15 yrs) successfully completed both the pre-treatment and the post-treatment EPSI scan. The first scan was post-surgery but prior to initiating radiation and concomitant temizolomide (TMZ); the 2nd scan occurred on average after 7 to 8 weeks, so after 6 weeks of radiation (60 Gy) and TMZ. All patients were scanned at 1.5T (Siemens Espree) with a 12-channel head coil. The protocol consisted of a T_1-weighted MPRAGE (TR/TE=9/4.2 ms, 256x256x160 acquisition, 1 mm slice thickness) and spin-echo EPSI with water and lipid suppression (TR/TE=2000/70 ms, FOV 280x280x180 mm^3, 50x50x12 matrix, nominal voxel size = 0.5 ml). All data were processed using the MIDAS software package [3], and high choline ROI's were selected in the lesions. Averaged pre- and post-treatment Cho/Cr ratios were calculated for both the lesion and normal tissue in the contralateral hemisphere. A representative post-contrast T_1-weighted image and choline image are shown in fig. 1. Typical spectra are shown in fig. 2. Paired samples t-tests were performed using SPSS.

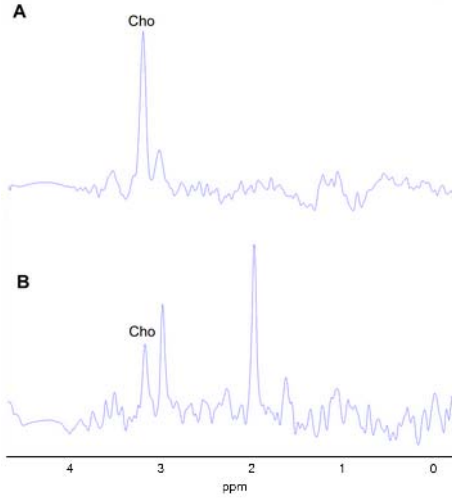

Fig.2: A) lesion spectrum showing a large elevation of Cho, and B) normal spectrum from the contralateral hemisphere in one patient.

Results: This abstract reports on an interim analysis of 8 of the 25 subjects. Both pre- and post-treatment lesion Cho/Cr ratios were significantly increased compared to normal brain (p=0.004 and 0.000) (fig. 3). The lesion Cho/Cr ratio decreased after 6 weeks of treatment, but did not quite reach statistical significance (p=0.053). The Cho/Cr ratio in normal brain was unchanged pre- and post-treatment. Based on the number of voxels with high choline counted, in 5 patients the high-choline lesion size decreased, 1 patient was stable, and in 2 patients high-choline lesion volume increased after 6 weeks of radiotherapy.

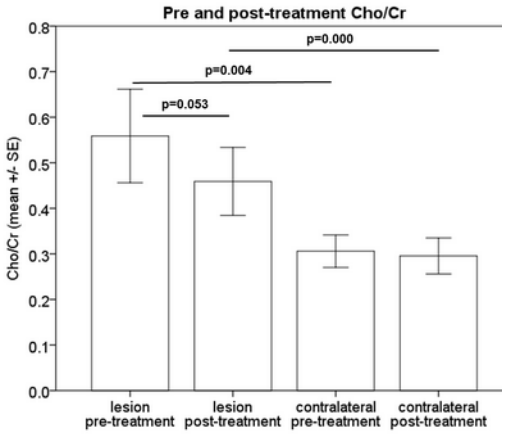

Fig.3: Pre-treatment and post-treatment lesion and contralateral Cho/Cr ratios.

Discussion: This study confirms that post-surgical, residual tumor can be detected by EPSI, and may be useful as an adjunct method for radiotherapy planning in the future. Also, the near significant reduction in Cho/Cr post-radiotherapy suggests that EPSI may have a role in monitoring treatment response. Ongoing analyses are being performed to confirm these findings, and to correlate with clinical outcome.

References: 1. Dowling et al. 2001, AJNR Am J Neuroradiol; 2. Parra et al. 2014, Int J Radiat Oncol Biol Phys; 3. Maudsley et al. 2006, NMR Biomed.